# The Data Horror Escape Room Game as a Successful Tool for RDM Education and Engagement

## Lena Karvovskaya

Vrije Universiteit Amsterdam, Amsterdam, The Netherlands, E.Karvovskaya@tudelft.nl, https://orcid.org/0000-0001-7777-5603

## Joanne Yeomans

Leiden University Libraries, Leiden, The Netherlands, j.yeomans@tudelft.nl, https://orcid.org/0000-0002-0738-7661

## Elisa Rodenburg

Vrije Universiteit Amsterdam, Amsterdam, The Netherlands, e.j.rodenburg@vu.nl, https://orcid.org/0000-0001-6068-9792

## Abstract

This paper presents a case study of how researchers can be engaged with the topic of Research Data Management in a playful and interesting way. The case in point is the Data Horror Escape Room, developed in 2020, a successful tool for facilitating discussion about research data management during educational, social, and peer-to-peer events. Escape rooms are games that are completed by solving a collection of puzzles and have been shown to be useful tools for game-based learning. The paper reflects on the steps that led to creation of the game, including its technical implementation using Google Sites and gives an overview of how the game was used and feedback it received. Readers are welcome to use the paper as guidance for reusing the escape room for their own events or as inspiration for building a similar escape room for their own purpose. The Data Horror Escape Room is openly available to access through a URL, and is archived as a dataset in Zenodo.

**Keywords**: RDM; research data management training; game-based learning; research support; library

## 1. Introduction

Research Data Management (RDM) is now a priority for many research libraries, and is reflected as such in the LIBER Strategy for 2018–2022 (LIBER Europe, 2017) and for 2023–2027 (LIBER Europe, 2023). The authors of this paper all work in libraries, and though they have varied job titles and responsibilities, they have a common role: the need to engage with researchers and help to improve their practices with regards data management, FAIR data, and data publication. Capturing the attention of busy researchers is a challenge that requires constant innovation.

Prompted by the particular challenges of engaging with researchers during the lockdown in 2020, the authors collaborated to create an online escape room game featuring puzzles that explain selected aspects of RDM. The Data Horror Escape Room is a novel tool that educates, stokes interest, and elicits conversation about RDM during online and in-person events. It uniquely facilitates safe and engaging discussions on topics that sometimes prove challenging to raise with researchers. Although originally designed for one-time use, it became clear that the resource could be successfully reused in different settings, and with different communities. In hindsight, this knowledge might have resulted in different design decisions. The Data Horror Escape Room has been played at a number of different types of events with groups of varying size, skills, knowledge, and experience, and has proved to be successful in both educating players and in improving interaction among participants in those events. The team received three requests from colleagues who wished to reuse the game in another language. The game can theoretically be edited and adapted so that it addresses specific challenges or features of a particular institutional setting and the authors have shared copies of the game for others to use in this way. The authors have made considerable efforts in trying to find solutions for sharing the back-end of the game openly and in a FAIR way, however, having been built in Google Sites and Google Forms, it was not possible to find a perfect solution. Given the constraints at the time, a tool was needed that would enable geographically distributed collaboration, and have a relatively low technical barrier, and the Google suite offered a proven

solution for building an escape room (Chaudhry, 2020). The authors have, however, made the game findable and accessible, with a downloaded archival copy in Zenodo (Rodenburg et al., 2024), an accompanying facilitator's guide, and wide communication about its availability via social media. The game itself is available openly via https://sites.google.com/vu.nl/datahorror/.

This paper explains how the escape room was built, and positions its success, as a game-based learning tool, in terms of the challenges faced by libraries trying to successfully engage with research staff on RDM.

## 2. Innovating and Improving RDM Training and Engagement Methods

In the years before the pandemic, university-specific engagement and training with researchers was most frequently delivered by library staff in face-to-face settings using traditional methods of teaching: often a combination of presentations and discussion, perhaps with small activities aimed at engaging participants in the topic, encouraging collaboration and sharing of ideas, and hence reinforcing learning.

RDM training sessions might be generic, aimed at researchers from different faculties in one session, or faculty-specific where it becomes possible to devote more time to domain-specific issues, for example dealing with very large data sets or privacy questions. A common problem is the need to capture a wide range of RDM topics in a one-off, time-limited training session.

RDM training commonly focuses on one or more of the following activities:

- Data management planning (typically at the start of a research project);
- Issues when dealing with personal or sensitive data;
- What is, and how to produce, FAIR data;
- Publishing data in a data repository.

In order to talk about these activities, it is often necessary to explain terminology: for example, what is meant by FAIR data, persistent identifiers, or metadata; and to introduce completely new concepts, such as licensing, metadata, or standardisation.

One of the difficulties in teaching RDM is that it is not a single procedure that must be followed, but a range of concepts that must be understood and subsequently applied within the particular research project of the researcher. The researcher needs an understanding and awareness of a relatively wide range of issues covering the data life cycle from data collection, through storage and sharing, to archiving and publishing, and touching on a diverse range of challenges from IT risks, to privacy restrictions. They then need to be able to think about how to apply RDM in their own research to avoid pitfalls and increase the reproducibility and reusability potential of their research.

Teaching RDM to researchers can sometimes meet resistance when researchers feel that RDM is an administrative task, or that the terminology and concepts are irrelevant to them and their research. It is also still relatively uncommon for RDM training to be compulsory for research staff, though it might sometimes be a requirement for PhD candidates. However, the benefits of good RDM for research and to the individual researcher are undisputed, so it is important to make training sessions engaging, interesting, educational, and academically relevant, to counter this resistance and achieve good learning outcomes.

This situation resembles the one known from Open Access: "The struggle to increase [OA] engagement overall could be due to the training not being appealing enough, and academics not being aware of benefits until after they have attended workshops" (Sundsbø, 2019).

In order to raise awareness beyond limited audience and limited contact time through teaching, many libraries may also try to communicate RDM messages by facilitating special events or campaigns. As a community of RDM supporters, we are constantly sharing ideas and techniques to do this in eye-catching ways, and a selection of successful engagement case studies from across the world were captured in the 2019 book, *Engaging Researchers with Data Management: The Cookbook* (Clare et al., 2019).

One engagement campaign that has been carried out in The Netherlands for several years is the "Data Horror Week". This annual campaign takes place in the week around Halloween (31st October) and has been used as an opportunity to raise awareness about good RDM practice and the support that is available, by sharing and learning from 'horror' stories of when things

have gone wrong or when disaster was avoided through good practice. The authors had already worked together in 2019, with RDM support staff from two other universities, on a successful Data Horror Week campaign to collect a set of stories[1] from researchers. These were disseminated online and complemented by open office hours and an event which brought researchers into the library.

## 3. The Escape Room as a Tool to Facilitate Online Interaction

In March 2020, as the COVID-19 pandemic threatened to explode, universities across The Netherlands took the decision to send staff to work from home. As we all know, this was an unprecedented change in work style, and there had been little time for planning or preparation. Suddenly, what had been carried out in-person needed to happen online. When it came to training, many people found that it wasn't possible to convert the contents of an in-person course into an online setting without making changes. Leiden University learned that the concentration span of participants was shorter during online teaching, and that you needed to work much harder to get interaction (Yeomans & Schoots, 2020).

In September 2020, following their previous collaboration in 2019, the authors from VU Amsterdam and Leiden University met online, along with Anne Aarts and Bart Aben from Eindhoven University of Technology, to brainstorm ideas for a Data Horror Week campaign that could be organised whilst working at home and delivered online. Some members of the team had played research support games, such as the DANS Data Game (Data Archiving and Networked Services [DANS], n.d., b), a Quartets, or Happy Families game, and the Game of Open Access (McGuinn & Spikin, 2017), a board game with elements of role play. They were also aware that other libraries had already been experimenting and promoting the use of both in-person (Sundsbø, 2019), and virtual/online escape rooms (Chaudhry, 2020; Dobbs, 2019). The team quickly recognised that a game could be a good way to engage with researchers in a fun way, stimulate discussion, and perhaps therefore improve learning outcomes. Having already had experience using online meeting tools and breakout rooms, they envisaged playing a team game online and bringing everyone together in a plenary afterwards to reflect on the experience and outcomes.

Escape rooms are a collection of puzzles that players need to solve, within a certain time or in competition with others, in order to escape from something (usually a room). They are normally team games, but games for individuals also exist. There might be hints to help complete the game, but the idea is usually that, even if the game is not completed, the players enjoy the experience and discuss it afterwards.

One of the authors who had enjoyed playing an online escape room built by friends had gained some insights into the process behind its development and was convinced that the format could be adapted for the RDM audience. The team tested out this example of an escape room and agreed that this could be the basis for the one-off event, and wondered if the result might be something that could be used in a wider variety of training sessions and networking events in future.

## 4. Building the Escape Room: Technical Set-up and Project Management

The target audience of most of the RDM training and engagement that is carried out in universities is research staff, PhD candidates, and research support staff from across the university, and this was therefore agreed as the main audience for the game.

Inspired by other examples that gave the impression of being quite easy to design and build, the team decided that they could create something using Google Forms and Google Sites. The mechanics of using these tools to build an escape room had already been demonstrated by others, but the challenge was to find a way of incorporating RDM topics into the game in a fun way. Furthermore, the team wanted to make the game the focus of an online event so the game had to be fun for a large number of participants.

The team broke down the challenge into the following steps, which are then detailed below:

    (i)   outlining the 'plot',
    (ii)  creating the individual puzzles,
    (iii) implementing the puzzles technically,
    (iv) harmonising the puzzles with the story,

(v) ensuring the game is coherent,
(vi) testing the game for group play.

Because the task of designing puzzles was distributed across the team, and the team was working asynchronously, the escape room ended up with a variety of puzzles all in slightly different formats. The lack of consistency regarding how the puzzles were implemented, however, proved to remove some of the predictability and therefore make the game more exciting to play.

The team was able to carry out the project in less than two months. Most of the work was performed asynchronously with regular short meetings to discuss progress. There were complementary styles and roles: someone with more technical skills, another with funny ideas, another who could check consistency, another who could be more critical. It was important to have a clear timeline and a deadline worked out in detail from the start, including some time for testing and adapting the game if necessary. The team scheduled two test plays with colleagues and these sessions served as intermediate deadlines before the final launch of the game.

### 4.1. The Plot

Whilst trying to work out how someone might 'escape' the room, the team landed on the idea of the player having to submit a data management plan by a deadline, something that would be familiar to many of the intended audience. Some of the most frequent challenges that are encountered during training sessions could therefore be introduced: what is FAIR data, dealing with personal data, archiving data, data transfer, persistent identifiers, and metadata.

The original idea was to have puzzles that could directly produce some parts of the text that players could then assemble to produce a completed data management plan. This would closely reflect how a researcher might go about writing a data management plan in real life, but proved too difficult to create with the technical tools that were available, so an intermediate step was introduced that would require the players to collect a string of words that could be used to unlock an imaginary computer, from where the pre-prepared data management plan could be submitted. In line with typical escape room tradition, it would not be clear to players from the start of the game exactly how the escape could be engineered.

To link with the Halloween theme of Data Horror Week, a horror-movie-style scenario was imagined, whereby the protagonist is trapped in the dark and deserted office of a mysterious professor. The only way out is to help the professor submit a data management plan, but only by exploring the office space can they find out exactly what they need to do, and discover the puzzles which, once solved, reveal the parts of the necessary code. The original storyline, following the creation of a data management plan, provided a playful atmosphere and helped to connect all the puzzles.

The team took care to make the identifying features of the protagonist and the professor as vague as possible so that a wide range of players might identify with the situation. For this reason, the team began by deciding that the research details should also be vague, but as the puzzles developed, it started to become difficult to avoid any commitment, and once the team abandoned this restriction, it became possible to introduce hints of some mysterious, paranormal research which also brought some humour and fun into the game.

### 4.2. Creation of the Puzzles

After investigating how other escape rooms had created puzzles using Google Forms (Dobbs, 2019), jigsaw puzzles (https://www.jigsawplanet. com), and images, and after thinking about the kinds of objects one might find in an academic office, each team member was tasked with designing an idea for a puzzle related to an RDM challenge and to an office item or location. Ideas were brought back to the group for fine-tuning and resulted in the following locations and puzzles:

| | |
|---|---|
| Address book on the desk | Personal data: identify what is personal data, and then put five studies collecting them in order. |
| Wall map | Data transfer: moving data from one (physical or digital) location to another. |
| Notice board | Publishing data: using persistent URLs (DOIs) and standardised metadata (ORCID). |
| Filing cabinet | Data reusability: what metadata do you need to be able to cite and reuse a dataset? |
| Video camera on a chair | Making a dataset FAIR (Findable, Accessible, Interoperable, Reusable). |
| Waste paper bin | Archiving data: why archive data, and what might you need to consider when publishing data in an archive. |

Most of the puzzles present information and then, with a few twists, test the participant's understanding or their RDM knowledge, whilst one puzzle is a logical puzzle rewritten in RDM terms to familiarise or introduce ideas for later discussion.

The most challenging puzzle, in terms of finding the solution, requires players to leave the escape room environment to look at a real dataset (Colunga-Salas et al., 2019). Although the team considered creating a fake dataset for the game, they decided to risk pointing to a real dataset so that players could see an example of good practice in data sharing. By chance, a dataset was found with research particularly pertinent to the Halloween theme, and this inspired the team to introduce the research topic of the Professor and embellish the escape room environment.

The dataset is archived in Zenodo, a data repository that aims to archive data for the long-term with a persistent identifier. This is something that is encouraged for data archiving, so provides a demonstration of good practice and means that the dataset should not disappear. However, the game designers have no control over the dataset and therefore rely on its continued availability. By requiring players to view this real dataset, the access metrics recorded by Zenodo will increase. The team could not see any negative risk for the dataset owners. As an aside, this kind of use of a research output is not taken into account when relying on download metrics to assess research value.

### 4.3. Technical Implementation Through Google Sites

The Google suite of tools had been demonstrated by others as a successful tool for building escape rooms and VU Amsterdam was offering it for educational and training purposes. Having seen another escape room built on Google Sites,[2] the team chose it as a simple technical solution for building the escape room. The escape room is a set of interlinked web pages displaying basic text, linked text, image files, and pdf files, with most of the puzzles implemented through an embedded Google Form.

The website could be built with little technical knowledge, although mapping was needed to ensure the pages were interlinked in a way that users could explore and discover the pages they needed at the right moments. The

limitations of Google Sites were that the pages were static, so dynamic features could not be used during puzzle solving, and that the page files could only be shared via Google Drive, which is not as open and sustainable as the team would have liked.

When it came to the puzzles themselves, the team mostly used Google Forms to present the players with a question which required a validated answer to open a second page of the form displaying a single word. By collecting these words (outside the escape room, for example, by writing them in a separate document), they could construct the phrase needed to unlock the escape room. Each word was hidden from view unless, and until, the player had completed the puzzle.

The functionality of Google Forms allowed for two types of questions: those offering multiple choice answers, and those asking for a typed text answer. Intuitively, multiple choice seemed like a good way of testing players' knowledge while reducing possible typing errors. Unfortunately, as Google Forms are primarily meant to gather information, it was possible to validate the *number* of answers selected, but not to validate that these were the *correct* answers. The best way to validate answers proved to be by using open-text fields and functionality within Google Forms for defining a regular expression, which only allows a matching answer to be given.

As multiple-choice forms were created before realizing their validation limitation, a workaround was found requiring all answers to be correct (validation would be, for example, that all five possibilities should be marked by the participant). This meant that the team had to be a little creative and challenging with the questions so that it wasn't immediately obvious that all answers were correct.

Some of the puzzles were open text box format. The list of answers was alphabetised and players had to manually type the letters corresponding to the correct answers, and in this format, not all of the options needed to be correct. Using predefined regular expression functionality required exact matching, so as an extra prompt to make sure that players were aware of the need to be careful in the way they typed the answers, the team purposefully required each puzzle to be answered in a slightly different way, for example, using different punctuation between letters, or omitting spaces. Google forms validated the answers and only accepted the correct sequences.

### 4.4. Connecting Everything Together

Working out where the puzzles should be 'in the office' and how to connect them using intermediate pages was a fun team activity. The team struggled to determine an order of play which would lead to the moment of 'opening the door' to complete the game. Only once they had let go of this order limitation, did they realise that by allowing players to move freely around the website and attempt the puzzles in any order they chose, the game became more fun to play. The challenge therefore became how to unlock the final puzzle, in this case to submit the data management plan. This was when they had the idea of requiring a word or phrase that would unlock a computer and which would only be known once every puzzle had been completed.

The solution, to give a single piece of the key upon completion of each puzzle, meant that a phrase was needed containing the same number of words as there were puzzles and consisting of non-repeating words with a single order solution. This phrase could be validated in a Google Form using a regular expression in the same way as the other puzzles. The second page of the Google Form could display the data management plan, and pressing the submit button could complete the game. This conceptual solution proved crucial in bringing the puzzles together and making clear the flow of the game.

### 4.5. Immersing the Player into the Game

Once the puzzles and the solution were settled, everything needed to be given coherence with atmosphere and the little details that would flesh out the story. Free online pictures were sourced, and some new pictures created, small tweaks were made to the puzzles to bring alignment to the story, and small embellishments were made to try to bring the story to life.

The team tried to imagine how players would behave in a real-life escape room, and expected that players would first look for and examine the door to see what might be needed to open it. Therefore, with no door included in the game itself, a simple link was added that invites players to try to open the door, and when clicked, reveals a message telling them they need to submit a data management plan to open the door and escape. With this information,

players would next be expected to look around for a means to submit a data management plan. The computer is the most obvious answer, and is easily found, however, as in real life, it is locked with a password and therefore fulfils both the purpose of indicating how to play the game (namely to find the passcode), and a reminder that computers should be locked for security reasons. These two pieces of information: the need to submit a data management plan on the computer, and therefore the need to find a passcode, give the hints needed to set off to explore the room and play the game.

One or two of the puzzles were switched around to match items in the room most relevant to the puzzle's RDM topic. So the puzzle for data transfer is linked to a map on the wall showing the movements of the professor. The FAIR data puzzle was originally in a bag, but once the team decided that players should be guided to a video to help solve the puzzle, a video camera was introduced on which to 'play' the video, and the puzzle itself became the instruction manual. Several of the puzzles started out on the desk, but the team felt that players would feel more immersed if they had the sense of walking around a real room.

Looking at the escape room as a whole, the team thought that some red herrings might be useful for the gameplay. The team wanted these items to be low-key so as not to distract too much from the task at hand, but to help immerse players in the narrative and to fulfil a minor role. The first distraction is right at the beginning so players are invited to read some posters in the corridor rather than to go into the office. Players might think there was something to learn from these, but it was simply a way to link to the previous years' horror stories. During testing, all our players soon realised that this was merely a distraction and not part of the game but appreciated that it was a good way to get people to read these and think about coming back later. This distraction also had the purpose of setting expectations – nothing in the game was necessarily what it seemed.

The pile of old papers in the waste paper bin has no purpose except as a red herring, but again, the team chose to allude to a question that could be brought up in discussion later: had the professor thrown away any materials that would be better archived? Indeed, this red herring has been raised afterwards by some players who wondered aloud why it was there and went on to give their views on this issue. The itinerary of travel is similar: players sometimes pause to read and give some thought to where the professor

travels, in case it is relevant to the puzzle. It is not relevant to the puzzle, but of course is relevant to RDM, and players have wondered out loud what data is being collected, whom the professor is meeting, whether the countries are outside the EU, and what equipment has been used for the data collection.

The team made sure that none of the pages resulted in dead ends, so there was always a way to return to the central office page which acts as the index to the other pages. They also inserted some extra hints, either in the text, or as separate links, in anticipation of players becoming stuck at some of the puzzles.

### 4.6. Two Versions of the Same Game

Two versions of the game are now available: one that includes a feature whereby teams receive a timestamp upon completion, but which facilitators can only access via the VU Amsterdam Google suite, and another that can be used by anyone at any time and without special access. Both versions are hosted on the VU Amsterdam Google Drive, each with a different URL. The need for these two versions only emerged during testing.

Having spent weeks working over these puzzles by this point, the team were so close to the work that it was difficult to know if the puzzles were too simple or too challenging, whether the story was too silly, and whether the play would go as expected. Some colleagues not familiar with the project were selected to play the game whilst being observed. The team were delighted that everything went well, the puzzles were solved, though not too easily, and the players escaped from the room within about forty-five minutes. What pleasantly surprised the team was the amount of enjoyment experienced by the players, and the competitiveness that they showed on wondering how long it had taken them to complete it. The overall feedback was better than expected.

While working on the game the team had been very much focused on it being central to an event where multiple people play at the same time. After seeing how competitive the test players felt, they decided to make it possible to enter a team name in a Google Form and get a timestamp to record when the final submit button was pressed. One or more known gamesmasters can be given access to the Google Form via the VU Amsterdam environment to

see which player(s) completed the game in the shortest time and in this way, accurately identify the winner.

Additionally, the team decided to share the room as an independent resource and to give it a life beyond this single event in 2020. The timestamp feature is only available for game facilitators who have access to the VU Amsterdam Google Drive, and therefore the team decided to exclude the feature in the version for wider use. This resulted in a version where players reach the final page confirming that the game is successfully finished, but the team name and time stamp are not recorded. Besides the 'active' versions, the team also archived the game on Zenodo, although this version is only an archived copy that cannot be played (Rodenburg et al., 2024).

## 5. The Benefits of Game-Based Learning

Although the Data Horror Escape Room was not specifically designed with a lot of theoretical framework in mind (see the reflections section below), there is extensive scholarship about gamification in training and game-based learning (GBL). There are also several other games available connected to RDM or to Open Science, such as the LEGO® Metadata for Reproducibility game (Donaldson & Mahon, 2019), Curate! The Digital Curator Game (McCadden et al., 2012) and the Game of Open Access (McGuinn & Spikin, 2017).

However, all these games were designed to play during live, in-person events, and the team were looking for a game that could be played online in a virtual room.

The design team had only a little awareness of some of these games, and that this was an area of academic interest before launching the game, and although they did not take into account previous research findings, it was a pleasant surprise to find that the game matched well the requirements identified for effective GBL.

Shortly after the Data Horror Week launch in October 2020, the team were invited to the 2nd Research Support Games Day (Bray & McCutcheon, 2020) organised by Robert Gordon University Aberdeen and the University of Glasgow, Scotland, in December 2020. During this virtual meeting, they were introduced to a number of people interested in gamification of research

support, and the study of its use and effects. Thanks to Daisy Abbott, among others, the team gained insight into why the escape room can be successfully used to engage researchers in data management.

The game is very simple to play – there are no rules to learn and so players can focus on playing the game rather than learning how to play the game. The game has all the requirements identified by Tobias et al. (2011), as quoted by Abbott (2019), for effective learning: active participation, immediate feedback, dynamic interaction, competition, novelty, and goal direction. Feedback from players showed appreciation for the atmosphere created by the game design and details, along with the pressure of the escape room concept and competition, and according to Hamari et al. (2016) immersion in a game enhances learning. One of the comments from a games expert during the Research Support Games Day:

> "I think this game, more than any other we have seen so far today, encourages engagement with the subject matter – it really does require you to think about what constitutes personal data, metadata, et cetera" (Bray & McCutcheon, 2020).

The learning that players experience has three aspects:

1. direct learning: about RDM as a topic itself,
2. social and vicarious learning: via the interactions between players and interaction with the game, whether working as a team, sharing knowledge and skills, or working under time pressure,
3. reflective learning: what insight does the game reveal about real-life situations.

These last two aspects are just as important, if not more so, than the RDM information imparted through the game and it was these that have proved to be the most successful in terms of using the escape room as a learning and engagement tool. As explained in section 2, RDM is not a list of instructions to teach, but a set of concepts that must be understood and then applied to an individual research project. Researchers learn how to do this through engagement with peers and the game has proved useful in facilitating exchanges of knowledge and experience between the players.

Spontaneous discussion about RDM has been witnessed at every event when the game has been played, taking place both during puzzle-solving as well

as after the game when players like to reflect on which puzzles were difficult and why. Players very quickly engage with each other, offering opinions and experience in connection with the RDM issues raised, and also picking up on some of the more hidden lessons of the game: not leaving the submission of a data management plan to the last minute, thinking about what research evidence you throw away, and how you might create potential data-leak risks by leaving an office open, a recording device on a chair, or a computer unlocked.

The team found that the benefits of playing the game were greatest if that was followed by discussion and reflection, ideally with a moderator. For this reason, the team recommends organised group playing over individual playing when possible.

## 6. Launch and Use-Cases

The launch of the Escape Room was on 29th October 2020 and announced as an online event for those with no prior knowledge but a sense of humour (Karvovskaya, n.d.). It was proposed to play in teams of three people, and participants could sign up as individuals or together as a team. Active outreach was performed through mailing lists, newsletters, social media, and community links (for example, through the Open Science Community) to encourage students, researchers, and support staff, mainly at VU Amsterdam, to register and a prize was offered for the fastest team. The event began with a very short introduction and the organisation of participants into breakout rooms, then an hour to play the game, and a final twenty minutes to reflect, reward prizes, and wrap up the event.

The call was warmly received and researchers and support staff signed up enthusiastically bringing the total players to fifty. At that moment during the pandemic, there had been few opportunities to engage with colleagues or friends in fun activities, so the game came at a good moment to meet this need.

The event took place via Zoom, which at that time required breakout room assignment to be performed manually, which for fifty participants, took longer than anticipated. Once in the breakout rooms the players all received a link to the home page of the escape room and started their escape adventure.

No guidance was given on how to play as a team, so some teams had one person sharing their screen, and others worked independently whilst discussing through the breakout room what they were doing. Some teams worked together at the same pace and others divided the puzzles amongst the team members, pooling their discoveries and results to save time. Reflecting on how the roles were divided during the game could facilitate a discussion about the organisation of data management responsibilities in real-life situations

Most of the teams were able to finish the room in less than an hour and returned to the main Zoom room where they were greeted by the organisers and asked about their impressions. At the end of the hour the two winning teams were announced, both of which consisted of researchers rather than support staff. Those who didn't escape from the room in time were encouraged, of course, to continue playing after the event.

After this successful launch, the Data Horror Escape Room has continued to be used in training and education, social events and team-building, and peer to peer events. A flavour of some of these events is maybe inspiring for others wondering how it can be used.

### 6.1. Training and Education

The Data Horror Escape Room has been used in training settings with Masters students and PhD candidates, both at the authors' home institutions and externally.

At Leiden University it was played in 2021 and 2022 with two cohorts of a Masters class in Book and Digital Media Studies. These students were interested in both new research methods in digital humanities and the role of libraries in supporting new modes of research. It therefore created discussion about the importance of data management in digital humanities and the role of libraries in educating and supporting data management. The students loved the game and several reported sharing it with friends afterwards.

At both VU Amsterdam and Leiden during 2021 and 2022, it has been used during RDM training of PhD candidates. When time is limited during

training sessions, participants have been invited to play for half an hour, and then continue by themselves afterwards, and anecdotally, many have gone on to complete the game, with some even contacting others from the class to share their success. As Open Science is about culture change, and is driven by peer exchange and discussion, the game is therefore useful as a springboard for building a community of practice related to RDM, whether students, researchers, or research support staff.

Outside the university setting, it has also been played in educational settings with data stewards, researchers, and funding agency staff. The Dutch DCC Spring Training Days (Landelijk Coördinatiepunt Research Data Management [LCRDM], n.d.) were introduced as an annual series of national events in 2021, aimed at training new data stewards at universities and research institutions across The Netherlands. The game has been used each year to educate complete newcomers to RDM, and to help build community and interaction, all of which are important for a newly developing field of support. Researchers attending the Oncode Annual Scientific Meeting in July 2022 (Scheerders, 2022) were invited to register and play the game during a breakout session to learn more about data management. The Dutch Research Council (NWO) invited the authors to help facilitate an event to celebrate the fifth anniversary of their RDM policy in October 2021, and geared towards their own employees, especially those who were not already familiar with RDM and the NWO RDM policy. The gameplay was preceded by a short introduction to this policy.

### 6.2. Social and Team-Building Events

Some of the training and educational events mentioned above, such as the NWO afternoon, had a specifically playful setup in mind, but were still explicitly training events complemented by an educational discussion or presentation. Besides these, the game has also been played during events that were not meant for education or training of any kind, only for fun.

This was the case for the online DANS team-building day in late 2020. DANS is the Data Archiving and Networked Services, an institute of the Royal Netherlands Academy of Arts and Sciences and NWO (Data Archiving and Networked Services, n.d., a). DANS provides infrastructure for research data

and expertise about data management and preservation, so its employees are knowledgeable about RDM practices. Each year the DANS staff have the opportunity to engage in a team building activity and during the lockdown, it had become difficult to find something suitable. The authors were approached by DANS and verified that the escape room could be played just for fun. The authors helped facilitate the session online, and the employees enjoyed playing the game together, making the team day a success.

A similar session, but this time in person, was held in early 2023 with Leiden University library staff. Many library staff know something about RDM for their job; others have no need of RDM knowledge but like to know what others in the library are doing. A monthly lunchtime event is organised during which one library team presents something about their work. Normally the audience sits in rows and eats lunch quietly whilst a presentation is made; this time, participants were placed in groups of five or six around a table and one computer, and invited to compete against the other teams to complete the escape room. The room was filled with lively voices and cheers when a team had completed the game.

### 6.3. Peer to Peer Events

On several occasions, the Data Horror Escape Room has been played with peers as an example of new practice and to give insight into how RDM support staff engage with researchers. The goal has been explicitly to demonstrate how the game can be used, and to give insight into how it was created so that it can potentially be replicated in other contexts.

In December 2020, when the team participated in the 2nd Research Support Games Day, the participants were not interested in learning about RDM, but in learning about the range of games that exist and that are connected with research support in a broader sense. The escape room was presented, and then played by the audience, but no RDM context or educational element was included.

At the online LIBER Conference in June 2021, Elisa Rodenburg gave a presentation to highlight the game design of the Data Horror Escape Room to talk about the advantages and the challenges in building it (Swiatek et al., 2021).

At the Dutch National Open Science Festival in early September 2022, a digital poster was presented by the authors who went on to discuss with a number of participants the kinds of events in which it had been used, and explained how to facilitate an event during which the game is played.

At iPres 2022, the 18th International Conference on Digital Preservation (https://ipres2022.scot/) in mid-September 2022, Elisa Rodenburg was one of the hosts of the Game Room, a physical room where participants could go to play examples of games with a digital preservation theme and discuss with the creators the technical design and recommendations for reuse. Elisa hosted the Data Horror Escape Room and the Open Science Escape Room (Rodenburg et al., 2022) built in 2021 and received the iPres Award for Best First Time Contribution (Digital Preservation Coalition, 2022) which recognised that the team had:

> "created an engaging and thoughtful game that raised awareness of good research data management and FAIR principles. The game resulted in a lively discussion with participation from all groups and it was interesting to learn during the session how the game was built and used with researchers as well to convey concepts" (Digital Preservation Coalition, 2022).

The game ended up having much more potential for reuse than the team could imagine at the beginning of the project.

## 7. Feedback from Players and Game Facilitators

At the launch event, the team asked and received feedback from the players. Once it became clear that it would be possible to play the game again with new players, a feedback form was added at the end of the game asking any player completing the game: "Do you have any questions or comments about the Escape Room?".

As mentioned in section 4(vi), the team also created a duplicate version of the game that has been shared openly to enable individual play and independent facilitators to host the game. Making an openly available game has meant that it is impossible to know exactly how many times it has been played, and during what kinds of events. Only when facilitators or players have made

themselves known to the authors, or when players have submitted comments via the feedback form, has it been possible to record feedback.

Feedback has mostly focused on three areas: the technical setup, the experience of playing (both relating to the content and to the experience of playing virtually and in teams), and the educational value of the game.

### 7.1. Feedback on the Technical Setup

Using Google Sites and Google Forms for many of the puzzles had as its main advantage that it was easy and intuitive to use for game developers who had limited experience with web development. However, as explained earlier, the need to validate answers submitted via multiple choice tick boxes in Google Forms came with the limitation that all answers had to be correct. This elicited some confusion among some players during game play, making them think they had done something wrong, or that there was something wrong with the game. Players who recognise this limitation may also stop reading the question knowing they simply need to select all the answers.

A more general concern was in using Google at all, as the company is known to collect all data from its services, and therefore any data or feedback provided by players of the game. Although it is not necessary to have a Google account to play the game, players are prompted to log in without it being necessary, and those who are already logged into Google are recognised. The team were aware of these issues, but at the time, were not aware of alternatives for building an escape room, like Twine (Interactive Fiction Technology Foundation, n.d.), an open-source tool that can be used for game development. Most online guides for making escape rooms, that have appeared as a response to the proliferation of online games during the pandemic, still tend to recommend using Google Sites and Google Forms.

### 7.2. The Experience of Playing

The team has received many positive comments about the creativity and the fun that was built into the game. Players especially enjoyed the jokingly horror theme that was built into both the text and the puzzles, and appreciated the red herrings and dead ends that were a deliberate part of the game.

One issue that has been encountered from time to time is that some players, unfamiliar with the escape room concept, struggle knowing how to start. One option to address this is to briefly explain at the start of an event how an escape room works, another is to leave players to explore and struggle with this, then address it as a learning exercise about the research environment: how those with different cultural backgrounds, for example, might not understand how to navigate a specific university system and therefore might struggle to keep up with those who are more familiar.

Comments on the difficulty of the puzzles are more difficult to address: some players found some of the puzzles too difficult, and others found them too easy. Most players do appear to be able to solve all the puzzles eventually, but ideally, there would be a more interactive way of presenting hints relevant to the challenge that was being encountered. There are some hints in the game, but the team have still found that the facilitators do have a role to play in helping players if they have questions or get stuck, so it is also useful to make sure facilitators have played the game and noted the solutions for reference.

Those players who had joined an event and played in teams reported that they loved playing together, sometimes meeting new colleagues, and enjoyed the competitive element of the game – with or without prizes for motivation. Negative feedback about the time it has taken hosts to assign teams to breakout rooms, the ability to ask questions from a breakout room, team interaction when working virtually, or problems sharing screens, are common to those of us who have delivered online events and not specific to the escape room itself.

### 7.3. Educational Value of the Game

When asked, at the launch event, whether they had learned something, most players said they had, even if it was only a little. Those who were already familiar with the topics presented and did not learn anything new still said that it was a good way to create awareness about RDM topics and prompt discussion. Players also agreed that the escape room was, in their opinion, a suitable tool to teach researchers and others about RDM practices. Players of the game since its launch, who have submitted comments via the anonymous

feedback form at the end of the game, have been in agreement if they have mentioned the educational value.

### 7.4. Feedback from Facilitators

When facilitators have reported back on their use of the Escape Room, comments have mostly related to the organisational setup of the game. Crucially, the game is often attempted during an hour-long session and cannot be introduced and completed by everyone before the deadline, especially if players are relatively unfamiliar with RDM practices.

Facilitators also frequently expressed the need for a cheat-sheet giving them solutions to puzzles and explaining the reasoning, or giving some context or explanation to the puzzles or game play. The authors have now made such a facilitators' guide available on Zenodo (Rodenburg et al., 2024).

Much of the feedback received from facilitators has related to events with Masters students, research staff, and support staff, but not often with PhD candidates. This is surprising to the authors, because PhD candidates were the main target audience of the game, but it could be that events with this group go smoother than with other groups.

Facilitators without access to the team registration and timestamp, but wanting to accurately identify a winner, need to come up with an alternative system. On one occasion, the facilitator asked players to make a screenshot of the final page which also showed the time on screen, therefore creating their own timestamp. Facilitators mostly, however, rely simply on vocal announcements and a visual verification of completion, to identify winners.

Through events, and through contacts via social media, the team has received several requests from peers for access to the back-end of the site so as to copy, adapt, translate, or recreate it. Unfortunately, one of the drawbacks of using Google Sites was that the source files could not be shared more openly and this is discussed further in the next section. However, the team is happy that many others are benefitting from their work. The fact that the game was appreciated by such a wide audience indicates that it struck a chord with the research (support) community and caters to a need in research skills training.

## 8. Lessons Learnt and Reflections

The team originally imagined they would build a very quick, simple game, for a single, fun event, and because of time pressure they carried out very little research or planning before diving into the design and execution. Only after the Escape Room turned out to be such a success did the authors realise there was a much greater potential for such games than they had initially considered. And only then did they start to delve into the scholarship of game-based learning. They had no inkling that what they were creating would go on to be used in training and education so apart from giving some cursory thought to the areas of RDM they would incorporate, they gave little consideration to intended learning outcomes: what exactly it was that they wanted players to *do* and *learn*. What is more, the team created multiple-choice questions without really considering the 'diagnostic power' that incorrect answers would have; that is, how the incorrect multiple-choice answers could be a learning/teaching tool for players and facilitators (Brown et al., 2023).

Most of the puzzles are quite normative, presenting players with (sometimes multiple) correct answers, but they do not really invite players to discuss or justify their answer. Part of the original team explored a format without correct answers in 2021 when building the Open Science Escape Room (Rodenburg et al., 2022). In 2022, part of the team was also involved in building a new game, the Software Horror Escape Room (de Boer et al., 2022), using Twine instead of Google Sites and Forms.

The team building the original Data Horror Escape Room had more luck than judgement in finding a way to bring the puzzles together and unlock the escape room. If designing a new room, they would give this far more thought at the beginning and first create a design for the game flow. As it was, a solution was found, but this did cause delays mid-way through the creation of the game and some concerns that the game would not work at all.

Also lucky, considering how well the game has taken off in international settings, was the choice not to make puzzles too institutional-specific, although the puzzle about data archiving does focus on two data repositories commonly used by Dutch researchers and hosted in The Netherlands. At least one institute has asked for access to the files because they wanted to adapt the game to more closely reflect their own RDM infrastructure and protocols, and two requests have been received to translate the escape room into

Catalan and Slovenian. Although it is possible to download files and share them with known contacts, it would have been nice if the game could have been made more accessible and open to others wishing to adapt or build upon it. For FAIR purposes, the authors also wanted to preserve the website and publish it for the long term and with a persistent identifier. It became clear then that the options to export the Google Site were very limited. It turned out to be impossible to export the entire website as an xml or html file and archive that file. In the end, the authors contacted the website archiving team of the National Library of the Netherlands, who recommended a tool to archive a 'recording' of the website, with supplementary files for the Google Forms and the embedded pdfs. Similarly, it is not possible to make the back-end of the website available as an independent resource, so that others may use it to create their own resource; it is only possible to do so upon request.

Several approaches have been made by others wishing to run an event using the Data Horror Escape Room asking for a facilitator's guide. They have asked for the answers to the puzzles, for guidance on how to introduce and start the game, and for ideas on how to facilitate post-game discussion. The team originally did not give any thought to producing such a guide, and resisted the idea, thinking it would create a risk that players would discover the answers and cheat. But having run events in the months and years since the game was created, they have found themselves in need of such information to refresh their own memories. A guide has now, therefore, been written and shared online (Rodenburg et al., 2024).

One simple lesson learnt from the whole exercise was that collaboration is key to building such a resource: working with others, especially colleagues at different institutions, boosted creativity and improved the finished product. It was still useful to have one person responsible for the technical structure of the game, ensuring that the puzzles worked and there was uniformity to the file and folder organisation, and one person to look at the overall flow and coherence, but having a team of people with different backgrounds and approaches helped to bring variety, and therefore more fun, into the game itself.

Overall, the reception of the game has shown that game-based learning is well-received by an audience of researchers, support staff, and students, and that in a relatively short time, a meaningful and useful resource can be created, that brings benefits far beyond the time and effort invested.

## 9. Conclusions

The Data Horror Escape Room was built in two months by a team of five people and intended for a single online event in 2020. Since then, the authors or people known to the authors have facilitated the playing of the game, online and in-person, in more than 10 events, in 4 countries, and by an estimated 300 people, with probably at least as many others playing it individually or independently. It is useful as a training and educational tool, as a focus of a social or fun event, and as a way to engage with peers or decision makers and show the kinds of work that are carried out in RDM support.

Technically, the game was simple to build, and the technical structure can be replicated using different puzzles and a different game setting for a different educational focus. Escape rooms are successful in game-based learning, having the elements needed to bring about effective learning. However, some of the success of this particular escape room is a result of how the RDM information is embedded into the puzzles and the immersion of the players into the virtual escape room which is brought about by the design of the game and attention to details. Team members with experience of playing games outside the work setting have an understanding about what makes games fun to play. It also helped having staff who do not normally work together bring their different ideas of what the game might be, and collaborate outside their day-to-day work setting, making this a perfect cross-institute collaboration activity.

The Data Horror Escape Room was a very good investment of time and has been a focus of many varied sessions, bringing unexpected opportunities to engage with audiences in new ways, such as funding agency staff, other library staff, Masters students, and research groups. It continues to be used regularly almost three years later, and will probably continue to be used for some years to come.

What the authors might have done differently is to give more consideration from the start to intended learning outcomes, as they did for the escape rooms built subsequently in 2021 and 2022 (de Boer et al., 2022; Rodenburg et al., 2022, respectively). They would also have tried to find a way to make the back-end of the escape room more accessible to those wishing to adapt it (for example, de Boer et al., 2022), and to make a guidebook available earlier so that other facilitators could more easily run the game. The Data Horror

Escape Room has inspired others to think of gamification in the context of RDM and Open Science, and the lessons learned have therefore informed later projects, although the authors have no plans to rebuild the original Data Horror Escape Room. The process of building the escape room and its subsequent success have been highlights, bringing enjoyment to RDM not only for the players of the game, but also for the authors.

## Data Availability Statement

Where data are publicly available, they have been cited in-text and with the full reference below. Other data, particularly the data containing feedback received about the game, cannot be made publicly available due to privacy concerns and the promise by the team, at the time, that feedback would be treated confidentially. Should there be a strong need to review these data, one can contact the corresponding author through E.Karvovskaya@tudelft.nl.

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## Notes

[1] The results were hosted by LCRDM, the Dutch national coordination point for RDM [LCRDM. (2019). *Horror*. Retrieved 2 March 2023 from https://web.archive.org/web/20221129014642/https://www.lcrdm.nl/en/horror].

[2] Google Sites is a structured wiki and web page creation tool included as part of the free, web-based Google Docs Editors suite offered by Google: https://sites.google.com/.